Total Sulfur Option

User's Manual

(Addendum to Model 330S & 331S H2S Analyzers User's Manual)







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TABLE OF CONTENTS

1.0	Introduction	1
1.1	About this Manual	1
1.2	Key Symbols	1
1.3	Warnings and Cautions	2
2.0	About H2S	3
2.1	Hydrogen Sulfide Properties	3
2.2	Hydrogen Sulfide Quantities and Health Effects	4
3.0	Total Sulfur Option Overview	5
3.1 3	Principle of Operation .1.1 How it works	5 5
3.2	Total Sulfur Reaction Furnace	5
3.3	Hydrogen	6
4.0	Installation and Start-up	8
4.1 4 4	Installing or Replacing the Combustion Tube .1.1 Connecting Vacuum Fitting to Quartz Tube .1.2 Leak Checking Furnace	
4.2	Hydrogen Flow and Sample Flow	10
5.0	Total Sulfur & Hydrogen control options	10
5.1	331S/330S TS Only	10
5.2 5	330S/331S H2S & TS with Mode Switching .2.1 330S/331S H2S & TS with Mode Switching and Hydrogen Saver	10 11
5.3	330SDS/331SDS H2S & TS with Hydrogen Saver	11
APPE	NDIX A – Drawings and Diagrams	12
330	S with Mode Switching Outline & Dimensional	13
330	SDS with H2 Saver and H2 Pressure Switch Outline & Dimensional	14
331	S Total Sulfur Outline and Dimensional	15
Tota	al Sulfur Oven Break Down	16
H2S	Total Sulfur with Ethernet Card, Pressure Switch and Powered A/O Electrical & Connection	17
330	SDS with H2 Saver and H2 Pressure Switch Process Flow Diagram	18
331	S Total Sulfur Process Flow Diagram	18
APPE	NDIX B - Recommended Spare Parts List	19
APPE	NDIX C – FAQ & Troubleshooting	20

Table of Figures

Figure 1. Total Sulfur Oven Cutaway	_6
Figure 2. High Temperature O-Rings and Ultra Tor Elbow/Fittings	_9

1.0 INTRODUCTION

1.1 About this Manual

The Total Sulfur Operator's Manual should be used in addition to the Model 330S & 331S Hydrogen Sulfide Analyzer Operator's Manual. This manual contains a comprehensive overview of Envent Engineering's total sulfur addition to their hydrogen sulfide (H2S) analyzers as well as descriptive installation and startup instructions.

This manual should be read and referenced by the person who will install, operate, or modify the Total Sulfur Analyzer. Take time to familiarize yourself with the content of this Operator's Manual, reading each section carefully so you can quickly and easily install and operate the analyzer.

The manual includes images, tables, and charts that provide a visual understanding of the analyzer and its functions. Take note of all the caution symbols and notes, as they will alert you of potential hazards and important information.

1.2 Key Symbols

The following symbols are used throughout the manual to call attention to vital information. We recommend familiarizing yourself with them before reading further.



Indicates a potential hazard that, if not properly addressed, could result in damage to the equipment or injury to the operator.



1

Caution: hot surface.

Indicates additional information intended to help clarify an earlier statement or to aid in the reader's understanding of a given topic.

1.3 Warnings and Cautions





CAUTION: Quartz reaction tube is fragile and is removed during shipping, handle with care.



CAUTION: Do not apply power or hydrogen to the total sulfur furnace until the reaction tube is installed and leak tested.



CAUTION: Do not operate the total sulfur furnace if a leak is present.

2.0 ABOUT H2S

2.1 Hydrogen Sulfide Properties

- Physical State Usually encountered as a gas.
- **Odor** Characteristic smell of rotten eggs at 0.5 ppb; paralyzes the olfactory nerve around 100 ppm.
- Vapor Density Heavier than air (1.19 compared to 1.0 for air) > In gas mixtures, it will be present wherever the gas mixture is found> Gas mixtures may be heavier or lighter than air, depending upon their vapor density and temperature compared to the ambient atmosphere (i.e. usually air)> In its pure state, or as a high proportion of a gas mixture, it may flow or settle into low-lying areas, such as pits, trenches and natural depressions.
- **Flammability** Flammable at 4.3 46 percent vapor concentration in air, by volume. Burns with a blue flame and gives off Sulphur dioxide (SO2) gas SO2 is also hazardous and irritates the eyes and the respiratory system.
- **Solubility** Soluble in water and oil, solubility is inversely proportional to fluid temperature.
- **Common locations for H2S** Hydrogen sulfide, or H₂S, is a naturally occurring gas found in a variety of geological formations. It is also formed by the natural decomposition of organic material in the absence of oxygen. Some common locations are piping systems, pipelines, wellheads or wellbores, vessels, production facilities, tanks, pits, and low spots, confined or enclosure spaces, shacks or buildings, bermed or diked area, sour spills.
- **Corrosiveness** H2S is one of the most active corrosive components in gas-water-air environments.

2.2 Hydrogen Sulfide Quantities and Health Effects



Less than 1 ppm

You can smell it.

10ppm – 20ppm

- No known health effects for most people
- For 10 ppm or less, the exposure limit is 8 hrs. (Check your local legislation as they vary.)
- For 15 ppm, the exposure limit is 15 min. with 60 min. breaks. (Check your local legislation as they vary.)

20ppm-200ppm

- Eye and respiratory tract irritation and loss of smell.
- Headache and nausea, loss of smell after 2-5 minutes.
- Respiratory Protection is required beyond this level such as SCBA (Self-contained Breathing Apparatus) and SABA (Supplied Air Breathing Apparatus)

200ppm-500ppm



Above effects, but sooner and more severe.

Loss of breathing and death in 30 minutes to 1 hour.

500ppm-700ppm

- Affects the central nervous system.
- Rapid unconsciousness, cessation of breathing, and death.



700ppm and above

- Immediate loss of consciousness.
- Permanent brain damage and death in a few minutes even if removed to fresh air at once.

3.0 TOTAL SULFUR OPTION OVERVIEW

3.1 Principle of Operation

Envent Engineering's H2S analyzers (Models 330S/DS & 331S/DS) uses H2S sensing tape which reacts only when in contact with H2S. The total sulfur option involves the addition of a total sulfur reaction furnace (pyrolysis furnace) to a Model 330S or 331S. The furnace converts all sulfur compounds into H2S, allowing the H2S analyzer to read total sulfur as per the ASTM D 4468-85 "Standard Test Method for Total Sulfur in Gaseous Fuels by Hydrogenolysis and Rateometric Colorimetry".

3.1.1 How it works

- A sample gas mixes with hydrogen.
- The sample gas-hydrogen mixture flows through the reaction furnace and is heated to ~1000°C.
- The heat in the furnace forces the mixture to react, as shown in the equation below.
- Hydrocarbon compounds will dissociate to methane.
- Sulfur-hydrocarbon compounds, such as mercaptans, will dissociate to hydrogen sulfide.

$$R - S + H_2 + heat \rightarrow R - H + H_2S$$

Equation 1. Total Sulfur Reaction

• Dissociated hydrogen sulfide is then measured by the analyzer as total sulfur concentration (H2S included).

3.2 Total Sulfur Reaction Furnace

The Total Sulfur option comes standard with furnace temperature control circuitry. It also consists of a reaction oven, flame arrestors, hydrogen and sample flow meters, and an optional 3-way solenoid valve to allow the user to measure both H2S and total sulfur on an alternating basis, or the use of an SDS to measure TS consistency.

The furnace has a low temperature switch which will actuate the Analyzer Fault LED and relay upon furnace failure. The low temperature alarm may be present for up to one hour after applying power until furnace reaches operational temperatures.





WARNING:

i. Dual Seal maximum working pressure is 2 PSI.



- ii. Leaks are indicated by monitoring the ball in the H2/Sample Flow meter during a pressure test.
 - a) Lack of flow can indicate the possibility that a failed primary seal condition could exist in the Quartz Tube/heater assembly.

3.3 Hydrogen



The total sulfur analyzer requires ultra-high purity (UHP) hydrogen at a flow of 200-300 cm³/min. UHP Hydrogen has a minimum specified purity of 99.9999%. Lower grades of hydrogen may contain sulfur compounds or other impurities which will cause inaccurate results. Consult the factory calibration sheet for the flow rates for your application. It is advisable to have at least two bottles on site with dual regulators or a changeover regulator set. The hydrogen regulators must be new and clean. Dual stage, high purity regulators are recommended. Regulators with an elastomer diaphragm (rubber or Buna) are not recommended as they will allow oxygen to diffuse into the hydrogen supply.

The following table (Table 1) will give an estimate of bottle life, in days, based on a K type cylinder (9.25" x 60") without any leaks or calibration runs. Our calculations are based on a 200 cm³/min (flow of 2 on a A-157-1 flow meter). Assuming each analysis will run 3 times every six hours, Envent suggests the bottle should be checked at least 10 days prior to the estimated end of life.

	Analysis Every 6 Hours	Full Time Flow
2000 PSI	254	25
1500 PSI	190	19
1000 PSI	118	12
500 PSI	59	6

Table 1. Estimated Hydrogen Bottle Life in Days.

4.0 INSTALLATION AND START-UP

Note 1: The furnace power should be disabled by removing fuse on the main board.

Note 2: The power should be left off until the leak testing is complete.



CAUTION: Quartz reaction tube is fragile and is removed during shipping, handle with care when installing.



CAUTION: Do not apply power, or hydrogen to the reaction furnace until the reaction tube is installed and leak tested.



CAUTION: Total sulfur furnace housing and all components inside of the furnace including the reaction tube, may be hot if not cooled for the appropriate amount of time.



CAUTION: High temperature O-rings must be replaced after each use. Failure to do so will void the warranty.

4.1 Installing or Replacing the Combustion Tube

Use TS furnace explosion drawing in Appendix A to refer to appropriate parts coinciding with the following steps.

- Turn off the total sulfur furnace and let cool for a minimum of an hour.
- Remove the covers from the total sulfur furnace enclosure. (3)
- Slide the quartz (high temperature glass) tube into the ceramic furnace. (5)
- Substitute the O-rings with new high temperature O-rings if they have been previously used in the oven.
- Ensure the high temperature O-ring and ferrule are present and oriented correctly, shown below (figure 2).
- Perform leak check of the total sulfur furnace as per steps in 3.1.2.



Figure 2. High Temperature O-Rings and Ultra Torr Elbow/Fittings

4.1.1 Connecting Vacuum Fitting to Quartz Tube

- With quartz tube inside ceramic furnace, slide Ultra Torr nut, ferrule, and high temperature O-ring over the end of quartz tube. (1, 2, 3)
- Gently slide quartz tube into Ultra Torr elbow. (4)
- Align threads of elbow and nut, then tighten the nut **FINGER TIGHT.** Make sure not to put any lateral pressure on the quartz tube to avoid breaking or cracking it.

4.1.2 Leak Checking Furnace

- Cap the outlet of the furnace to begin the leak check.
- Set the pressure of inlet to 15 psig and open the flow meter to maximum value.
- When the ball in the flow meter drops to the bottom of the flowmeter tube, a seal has been established.

If the ball does not drop, a leak is present. Inspect and tighten all fittings, then repeat the previous steps until a seal has been established.



CAUTION: Do not operate the reaction furnace if a leak is present.

4.2 Hydrogen Flow and Sample Flow

The Process Flow Diagrams in Appendix A show the typical sample conditioning system used for the 330S & 331S Total Sulfur Analyzers. The total sulfur reaction furnace and an extra flowmeter, used to control the flow of hydrogen, are added to the standard H2S analyzer sample conditioning system for a Total Sulfur analyzer. See Appendices for overview and dimensional drawings.

Consult the factory calibration sheet in the documentation for your analyzer for the correct sample and hydrogen flow rates. An indicator for insufficient hydrogen is a yellow discoloration appearing on the Tygon tubing connected to the humidifier. If this happens, increase the hydrogen flow, or decrease the sample flow by 1. If changing any flow rates, the analyzer will need to be recalibrated at adjusted flow rate.

A shortage of hydrogen can cause coking, which is a black carbon build up in the quartz reaction tube. A light coating of carbon is normal and will not cause any operational problems. Excessive coking can lead to the quartz reaction tube getting plugged and a reduced sample flow will occur, additional coking can also absorb H2S causing lower than expected TS readings.

5.0 TOTAL SULFUR & HYDROGEN CONTROL OPTIONS

A pressure switch can be installed to ensure that if the hydrogen drops below 10 psig the analyzer will not switch to the total sulfur stream. This prevents coking of the combustion tube due to lack of hydrogen. See Appendix A for overview and dimensional drawings.

5.1 331S/330S TS Only

With a TS only configuration, the analyzer will only ever read the total sulfur values of the process stream. With the TS only configuration, the hydrogen must always be present to allow for proper reactions and prevent coking.

5.2 330S/331S H2S & TS with Mode Switching

Using a single sensor analyzer, it is possible to read both H2S and Total Sulfur, however, not simultaneously. A solenoid is added to allow to a selection between either running the sample directly to the analyzer (H2S mode) or through the TS furnace (TS mode). With this configuration, hydrogen will run full time.

5.2.1 330S/331S H2S & TS with Mode Switching and Hydrogen Saver

A second solenoid may be added to shut off the hydrogen gas when in H2S mode. This configuration saves hydrogen usage by a large margin (see table 1). The analyzer is typically programmed to run every 6 hours or alternate between H2S mode and TS mode each analysis; however, any schedule can be built to customer specification.

5.3 330SDS/331SDS H2S & TS with Hydrogen Saver

With a dual sensor analyzer (SDS) both the H2S and total sulfur can be measured simultaneously. Sensor one will read the H2S stream while sensor two will read the total sulfur stream. The addition of a solenoid allows the shut-off of the hydrogen if scheduled TS runs are programmed.

APPENDIX A – DRAWINGS AND DIAGRAMS

330S with Mode Switching Outline & Dimensional	pg. 11
330SDS with H2 Saver and H2 Pressure Switch Outline & Dimensional	pg. 12
331S Total Sulfur Outline and Dimensional	pg.13
Total Sulfur Oven Break Down	pg.14
H2S Total Sulfur with Ethernet Card, Pressure Switch and Powered A/O Electrical & Connection	pg. 15
330SDS with H2 Saver and H2 Pressure Switch Process Flow Diagram	pg. 16
331S Total Sulfur Process Flow Diagram	pg. 16



330S with Mode Switching Outline & Dimensional



330SDS with H2 Saver and H2 Pressure Switch Outline & Dimensional



331S Total Sulfur Outline and Dimensional



Total Sulfur Oven Break Down

H2S Total Sulfur with Ethernet Card, Pressure Switch and Powered A/O Electrical & Connection





330SDS with H2 Saver and H2 Pressure Switch Process Flow Diagram

331S Total Sulfur Process Flow Diagram



APPENDIX B - Recommended Spare Parts List

Part Number	Quantity	Description
1000123	1	Ultra Torr Elbow
3000022	1	AFLAS O-Ring Kit
1000065	1	1⁄4" Elbow
1100107	1	Flex Tube
1100115	1	Total Sulfur Temperature Switch
1000051	1	1/8" 1/3PSIG Check Valve
1300281	1	Group BCD Flame Arrestor
2000050	2	13'' Chubby Quartz Tube
1100113	1	TS Ceramic Heater

APPENDIX C – FAQ & Troubleshooting

Question	Answer
What is the oven internal temperature?	~1000 °C
What is the oven external enclosure surface	~50 °C
temperature?	
Can we read furnace temperature on the display?	No, but there is an oven fail alarm if the
	operational temperature cannot be
	maintained.
Do we need Total Sulfur gas for calibration gas?	No. The analyzer can be calibrated using
	strictly H2S calibration gas, however, the
	operation of the oven will not be verified.
Does Envent sell calibration Total Sulfur gas?	Contact Envent
How long does a hydrogen bottle last?	Check table in section 2.3
How long does it take the oven to warm up?	Approximately 1 hour

Problems	Possible Reasons	Possible Solutions
No Flow as	Coked quartz reaction tube	Replace tube and potentially fittings
indicated on		
flowmeters		
TS reading	Coked quartz reaction tube	Replace tube and potentially fittings, and
lower than H2S		tubing cleaning.
reading		
Oven Fail Alarm	Oven hasn't come up to	It can take up to an hour for the oven to
	temperature	come up to temperature from start up
	Temperature switch has failed	Replace temperature switch
Oven won't	Oven element has failed	Replace element
come up to	Oven has been programmed	Contact Envent for assistance
temperature	incorrectly	

Contact Us

In the event that a situation arises that is not covered by this manual, we encourage you to contact us so that we can help you resolve any issues you may have. Please have this manual readily available when calling for assistance.

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